ITR: A User-centric Content-based Approach to Indexing, Query and Retrieval of Music through Signal Processing and Knowledge-based Methods

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Project Summary

Providing natural and efficient access to the fast growing multimedia information, accommodating a variety of user skills and preferences, is a critical aspect of content-based information mining. Success in creating such systems helps us move toward the goal of universal access to information. Digital music is a key element in this information explosion. Tonal music, the music with which we are most familiar, is highly structured. This recognizable structure – in music and its cognition by humans – can be exploited in our search for better ways to organize, categorize and compare musical information.

The proposed research involves development of methods for content-based indexing of music databases using a combination of signal processing and knowledge-based methods, design of statistical algorithms for enabling queries using sung or hummed melodies, and design of robust search techniques for retrieving the queried information especially in the presence of uncertainty. The research approach, which is based on statistical modeling, is user-centric and comprises three major components: (i) Representation and Indexing – musical information utilizing theories and knowledge about human musical intuition, and music perception and cognition. (ii) Query Formulation and Interaction Modality – algorithm design for enabling interaction with music data through humming, a natural activity. (iii) Search and Retrieval – algorithm design to match user query against the database that will be robust to uncertainties and errors in the query generation.

The proposed architecture comprises a front-end recognizer, that converts the humming signal to note using a statistical pattern recognition approach, which interfaces with a back-end music database, that is indexed using perceptually viable features. The search process matching a query against indices is formulated as a statistical information retrieval problem. The proposal aims to employ progressively rich indexing representation including repeating patterns for recurring themes, chord, beat and key information. Derivation of such music-theoretic knowledge will benefit from a principled approach of mathematically modeling tonality in music. The statistical framework allows for handling variability and uncertainty in query formulation and retrieval. It also enables providing for quality of solution in the query results.

The investigators are engineers with considerable experience not only in signal processing, mathematical modeling, and content-based approaches for multimedia data management but also in the theory, modeling and practice of music. The project would serve as a vehicle to foster cross-disciplinary graduate and undergraduate research and education. Students will be recruited from both the School of Engineeering and the Thornton School of Music at USC. The research domain leverages USC's unique strengths in both engineering and music. The data, software and the research results would be disseminated through the project's website and enduring conference and journal publications.